tion of each calculated. A general list, including representatives of all the sciences, was also compiled by interpolation, but neither this nor the separate lists are published. An interesting table is given showing the divergences between the ten judges in the case of psychology, as an illustration. The order of merit given by one of the judges is very much more accordant with the average order than those of the others, and they differ considerably *inter se*, though more, if we understand the table rightly, in the case of those at the bottom of the list than of those towards the top. Of the first hundred scientific men on the list who are eligible, sixty-one are included among the ninety-seven members of the National Academy of Sciences. The discussion of the grades and probable errors is continued in *Science* for November 30, and in a third and concluding article in the issue for December 7 Prof. Cattell investigates the geographical distribution of American men of science, according to place of birth and place of residence. The figures as regards the former are extremely striking. The production or "birth-rate" of men of science per million of the population ranges from about 109 in Massachusetts—which stands far above the other States—and eighty-seven in Connecticut down to rates of only one or two in several of the southern States. It is argued that differences in stock can scarcely be great enough to account for this, and that accordingly the production of scientific men must be largely a matter of circumstance. As regards the place of residence, interesting tables are given showing the institutions with which the men of science taken into account are connected. The work forms part of an extended investigation which Prof. Cattell has now been conducting for some ten years, and on which he has published several previous memoirs.

WAVE ACTION IN RELATION TO ENGINEERING STRUCTURES.

A PAPER on wave action in relation to engineering structures, by Major D. D. Gaillard, issued as a professional paper (No. 31) of the Corps of Engineers of the United States Army, contains a great deal of information useful to engineers engaged in designing and constructing sea defences and other works subject to wave action.

The first part of the book is devoted to a general consideration of the theory of the formation of waves, and to a notice of the information that already exists as to this. This, as the author remarks, is embraced in so many volumes that the work of comparing theoretical and observed wave characteristics is rendered very tedious. The investigations that have previously been made into wave action, and of which the results have been published, relate principally to deep-water waves, whereas there is very little recorded information as to the action of waves in comparatively still water to which engineering structures are exposed.

Major Gaillard, the author of this book, was for several years engaged upon works of harbour improvement on the South Atlantic coast and the Great Lakes of America.

Although the waves to be dealt with in Lake Superior are not of the magnitude of those in the open sea, yet the author's observations cover waves of various dimensions extending up to 300 feet in length and 23 feet in height, and the results are recorded of several hundred observations of their length, height, period, and depth in which they broke and to which their effect extended. Numerous examples are also given of the effect of waves in moving large masses of stone and other material. The force of the waves breaking on piers, and other marine structures, was measured both by the marine dynamometer of the class used by Mr. Thomas Stevenson more than half a century ago and also by dynamometers of special construction made under the author's directions. The general type of the Stevenson dynamometer used had discs of from 3 inches to 9 inches, with springs varying in strength from 10 lb. to 50 lb. for every inch of elongation. The greatest dynamical force recorded with these when used at Dunbar, in Scotland, was 7840 lb. per square foot with waves about 20 feet high. These dynamometers only measure the dynamic, and not the static, pressure, and give only a maximum reading for a storm observation, and are affected in their working when there is much sand in the water.

The instruments invented and used by the author, besides the Stevenson type, consisted, in one case, of a steel plate, having an area of one square foot, attached to two elliptical springs similar to those used for carriages, the distance between their centres being 6 inches, the reading of the amount of compression due to the action of the wave being recorded by a rod attached to an index which acted on a paraffin surface. The instrument, before being fixed, was rated by having weights placed on the plates and noting the corresponding compressions. The other dynamometer used by Major Gaillard consisted of a plate covering a square foot attached to a horizontal cylinder filled with water; over the flange of this cylinder was placed a diaphragm of india-rubber $\frac{1}{4}$-inch in thickness, having a face of one square foot. A $\frac{3}{4}$-inch pipe led from the cylinder to a tank located in the observing station on the pier. From this pipe there was a communication to a modified form of Bourdon gauge fixed 19 feet above the centre of the diaphragm, and which registered pressures up to 30 lb. per square inch. Communication with the tank having been shut off, any pressure applied to the diaphragm was transmitted by the confined hydrostatic column to the gauge. More than a thousand readings of wave action were taken with this class of dynamometer while the author was in charge of the works, but only two storms of consequence were encountered. So far as the observations went, the instrument appears to have given satisfactory results.

The text is accompanied by a number of illustrations taken from photographs of waves.

SCIENCE IN EXAMINATIONS FOR THE HIGHER CIVIL SERVICE.

THE kind of education received and the subjects studied by future civil servants must have a great and far-reaching effect upon the influence exerted by the public departments which administer the multitudinous and diverse affairs of our scattered Empire. The methods adopted for the selection of such officers must, therefore, be wisely chosen, and, in any examinations designed to facilitate the process of discrimination between men offering themselves for these positions, the subjects in which candidates are tested must be those appropriately related to the work of the department in which successful candidates will be employed, and, at the same time, those most likely to test essential fitness for public work. These and similar principles have been widely canvassed recently both in public addresses and in the Press. Certain changes in the examinations for the selection of Foreign Office clerks and attachés in the Diplomatic Service are to be introduced, and the new regulations have not met with universal approval. It will assist clearness of thought first to compare briefly the existing regulations for the appointments concerned with those shortly to come into force.

Candidates for clerkships on the establishment of the Foreign Office and for attachéships in the Diplomatic Service will, after July 1, instead of being examined according to special regulations which have governed these appointments hitherto, be required to take the combined examination for open competitions for the Home Civil Service (class i.), India Civil Service, and Eastern Cadetships. This decision profoundly modifies the conditions of selection for service in the Foreign Office and the Diplomatic Service. In the past there have been nine obligatory subjects—arithmetic, handwriting and orthography, English composition, précis writing, French, German, general intelligence, geography, and the history of Europe from 1789 to 1880 inclusive. In addition, candidates have been able to offer any two of the following languages, viz., Latin, Italian, Spanish, Portuguese, Russian, modern Greek, and Arabic. In the examination which such candidates will have to take after July 1 next, papers will be set in thirty-two different subjects, from which a selection must be made by the candidate. French and German will be the only obligatory subjects, and candidates will have to reach a high qualifying standard in translation, composition, and oral examination in both

these languages. Portuguese, Russian, and modern Greek are no longer optional languages. The maximum marks to be obtained in each subject are, as a rule, 500 or 600, but 1200 may be scored in each of the two extensive divisions of mathematics included.

Though candidates for the appointments in the Foreign Office and the Diplomatic Service may make a selection from the long list of subjects referred to, the number of papers taken must be such that the maximum of marks that can be obtained from the subjects chosen is limited to 4000. Under the new conditions, the man who attempts to train himself by attendance at a cramming establishment, for the sole purpose of succeeding in the competition, will have a much smaller chance of success than a candidate who has graduated in honours after a university course. The student who has made himself master of any of the great divisions of knowledge will be able to acquit himself with credit. For example, 2400 marks may be gained in science, 2400 in mathematics, 1200 in French and German, 1800 in Latin and Greek, 1000 in Greek and Roman history, and 1300 in English and general modern history, but in any case the total number of marks attainable in the subjects selected by a candidate must not exceed 4000. The underlying principle seems to be to obtain somehow students who have benefited by a thorough study of at least one department of knowledge, of whatever kind; apparently the intention is to secure men of high attainments, no matter in what subjects they have specialised, and to insist upon a good knowledge of French and German from all candidates.

The schedule of subjects is sufficiently comprehensive to afford all ordinary students a fair opportunity to distinguish themselves. The candidate who has made science the staple subject of his university course will compete on almost equal terms with one who has studied classics and classical history, while the candidate who has specialised in modern languages and history need be at no disadvantage.

The comprehensive subject of geography, however, which is at present obligatory, is not included among the subjects from which candidates may, after July 1, make their selection, and it is this omission which has given rise to much discussion and many protests. In reply to a question on the subject in the House of Commons, the Foreign Secretary said:—"Although a knowledge of geography is no doubt very useful, it is a subject with which men of general education are generally acquainted, and which is easily acquired after entry into the service." Distinguished geographers have since shown how far this is from being the case. Sir George Goldie, in an address to the Royal Scottish Geographical Society in Edinburgh, published in the *Geographical Journal* for the present month, relates a notable instance of the difficulties to which a want of geographical knowledge may give rise. "A good many years ago a territorial arrangement with France was in discussion, and I was invited to consider it. The French proposals appeared to the Foreign Office satisfactory; but I found that they were expressed, as might have been expected, in longitudes reckoned from the meridian of Paris, while the map with which our Foreign Office had considered these proposals was made in Germany and reckoned its longitudes from the meridian of Greenwich. The arrangement in question was never completed."

Mr. Douglas Freshfield, in his address last Friday to the Geographical Association, of which he is president, dwelt upon the same point, and said he could give similar instances to that related by Sir George Goldie. Mr. Mackinder has shown in a recent letter to the *Times* that Sir Edward Grey's description of geography is that of the subject as it was studied twenty years ago, and not as it is now understood and taught. Substantial reasons have, in fact, been given for the inclusion of geography among the other branches of science from which candidates may make their selection.

It is hardly necessary to remind readers of NATURE that geography has in recent years taken its place among those branches of knowledge which are studied on scientific lines. No geographical teaching is now recognised by the Board of Education as satisfactory in secondary schools unless it has a basis of practical exercises and follows scientific methods. The subject has obtained university recognition, and is now taught by practical work in the laboratory and the field. As Mr. Mackinder has pointed out, "geography has its own modes of thought and its own points of view which are not to be obtained in a hurry." Mr. Freshfield was able to point out in his address, to which reference has been made, that there is evidence that the Civil Service Commissioners are beginning to reconsider the matter, and that it will not be long before the claims of geography will be fully recognised by the inclusion of the subject, dealt with in accordance with modern scientific methods, as one of those in which candidates may present themselves for examination.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The natural science board has issued a certificate stating that the work submitted by Mr. G. F. Herbert Smith, New College, is of sufficient merit to entitle him to supplicate for the degree of Doctor of Science.

WE learn from *Science* that Columbia University and Barnard College will receive 2000*l.* each under the will of Mrs. Annie P. Burgess.

SIR W. T. LEWIS has promised 1000*l.* toward founding a chair of mining at Cardiff College, University of Wales, provided 30,000*l.* is raised in contributions from coal owners, royalty owners, and workmen.

PROF. OTTO BENNDORF, professor of classical archæology at the University of Vienna, died on January 2 at the age of sixty-eight years. He was well known owing to his works on archæological subjects, and to the excavations he conducted in Asia Minor.

ADDRESSING a gathering of science and art students at Gravesend on January 2, the Earl of Darnley is reported by the *Daily Chronicle* to have made the following confession:—"I place myself before you as an example of deficiency in education. I went through the ordinary public-school course, and received a university education. I found myself at twenty-two a B.A. of Cambridge, with a certain knowledge of Latin and Greek, which I have never found of any particular use, but without any knowledge of French, German, or science. From my example I hope you will glean some benefit by securing that knowledge which it is now too late for me to acquire."

PROF. A. SCHUSTER, F.R.S., has resigned the position as Langworthy professor of physics and director of the physical laboratories in the Victoria University of Manchester. Prof. Schuster's connection with the University dates from 1871, when he entered Owens College as a student. In 1873 he held the post of honorary demonstrator in physics under Prof. Balfour Stewart, and in 1881 he was appointed to the newly-created chair of applied mathematics, which he resigned to become professor of physics in 1888. Both the Council and the Senate have placed on record by formal resolutions their regret at Prof. Schuster's resignation, which is to take effect at the close of the present session, and their sense of the very great services which he has rendered to the University by his work as a teacher, his direction and administration of the physical laboratories, his contributions to the advancement of science, and the prominent part which he has taken in relation to the re-organisation of the University. A general hope has been expressed that Prof. Schuster may still remain in close connection with the University, and take an active part in its affairs generally, as well as specially in connection with scientific research.

PROF. E. RUTHERFORD, F.R.S., Macdonald professor of physics in the McGill University, Montreal, has been appointed to succeed Prof. Schuster as Langworthy professor and as director of the physical laboratories in the Victoria University of Manchester. Prof. Rutherford is a native of New Zealand. After a distinguished academic career in the New Zealand University he proceeded to Cambridge as an 1851 Exhibition scholar, and entered